Center Independent Research & Development: GSFC IRAD

Core Flight Executive Software Radiation Mitigation Study

Completed Technology Project (2016 - 2017)

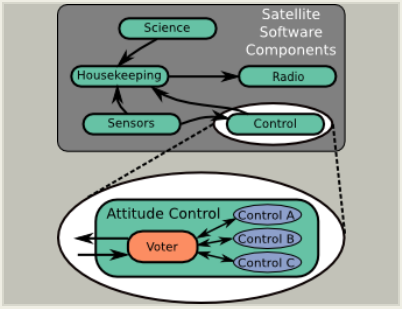
Project Introduction

The reliability of SmallSat / CubeSat missions may be increased by using software radiation mitigation for single event upsets (SEUs). Implementing protection in software results in a lower level of tolerance than traditional hardware techniques, but hardware costs and power requirements are kept to a minimum by taking advantage of nonredundant commodity hardware. This work will extend NASA's Core Flight Executive (cFE) to provide software based protection and evaluate the results so that informed decisions can be made about such trade-offs.

The project objectives are to answer the following questions about software radiation mitigation techniques applied to NASA's Core Flight Executive (cFE):
· How much can the occurrence of failures due to SEUs be reduced?
· What were the costs in terms of processor overhead?
· What are the impacts on normal cFE application development?
To answer these questions, this project will incorporate software radiation mitigation into cFE for an example CubeSat application. The primary protection mechanism investigated will be scalable modular redundancy of software components (applications). Scalable modular redundancy will be non-intrusive for cFE application developers and allow the level of redundancy to be adjusted as needed. Other techniques, such as source level approaches, may be employed for cFE itself if testing reveals potential reliability gains.

Anticipated Benefits

CubeSats will be able to increase flight software reliability by a quantifiable amount (with respect to SEUs) without increasing hardware costs or power requirements. Onboard science data processing will be made more reliable by detecting and recovering from silent data corruption, allowing more onboard processing which will reduce data downlink requirements. The scalable nature of the approach would enable missions that travel through multiple radiation environments to trade performance for reliability depending on the current environment.



The "Control" application is shown running in triplicate, using a Voter process to replicate inputs and vote on outputs.

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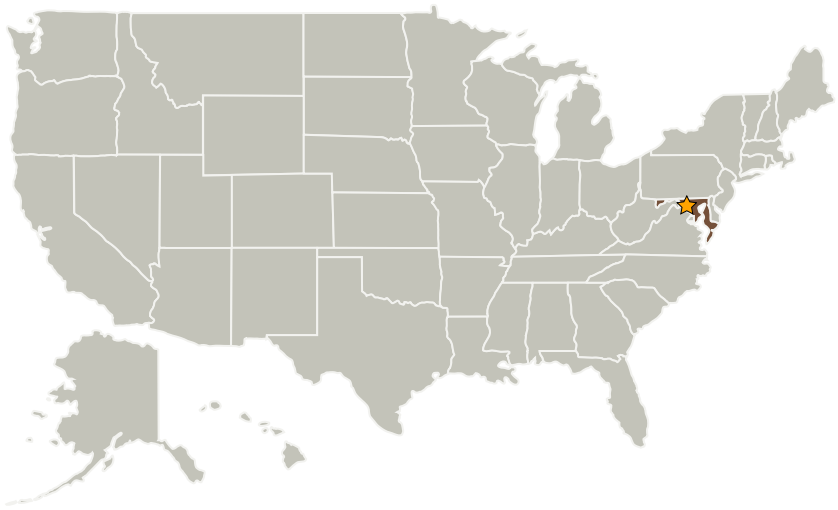
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Transitions

October 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

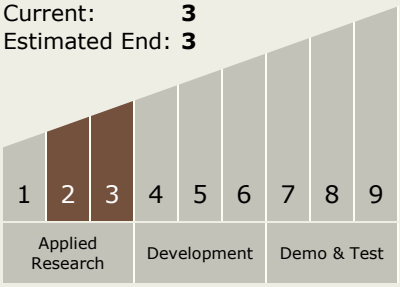
Jacqueline J Le Moigne-stewart

Principal Investigator:

James C Marshall

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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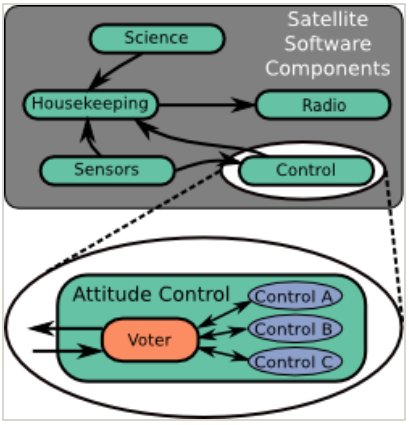
September 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center's Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard's IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

Images



Replicated_Software_Component
The "Control" application is shown running in triplicate, using a Voter process to replicate inputs and vote on outputs.
(https://techport.nasa.gov/image/26017)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.1 Software Development, Engineering, and Integrity
    - TX11.1.3 Test and Evaluation

Other/Cross-cutting:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.1 Software Development, Engineering, and Integrity
    - TX11.1.1 Tools and Methodologies for Software Design and Development

Target Destination

Foundational Knowledge